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Energy consumption (measured in weight of consumed food converted to kilocalories) was tracked for 7 bottlenose dolphins (*Tursiops truncatus*); 4 cows, and 3 calves. Data considered for cows began 18 months before and continued for 24 months after parturition; data for calves was tracked from birth to present. In the 6-month period following parturition, the kilocalories consumed by the cows ranged from 94 to 124 kilocalories, which was 129% to 204% more than before they became pregnant. The energy consumption of the calves is graphed, showing the high energy cost of growth.

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BOTTLENOSE DOLPHINS: ENERGY CONSUMPTION DURING PREGNANCY, LACTATION, AND GROWTH.

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ABSTRACT

Energy consumption (measured in weight of consumed food converted to kilocalories) was tracked for 7 bottlenose dolphins (Tursiops truncatus); 4 cows, and 3 calves. Data considered for cows began 18 months before and continued for 24 months after parturition; data for calves was tracked from birth to present. In the 6 month period following parturition, the kilocalories consumed by the cows ranged from 94 to 124 kilocalories which was 129% to 204% more than before they became pregnant. The energy consumption of the calves is graphed, showing the high energy cost of growth.

Lactation is attended by a considerable increase in energy cost for most mammals. The literature on energy consumption during gestation and lactation of bottlenose dolphins is very small and all the reports we could find involved a single animal. These accounts quantified dietary intake and related changes by weight as opposed to food value, i.e. kilocalories. Because we know that each species of food fish has a different kilocalorie value, that there are great variances within the same species, and that most diets are composed of a variety of fish, describing diet in terms of kilocalorie consumption allows for quantification. The results of this study are presented to quantify food energy requirements of bottlenose dolphins during pregnancy, lactation, and growth.

The subjects of this study were 4 female bottlenose dolphins and their offspring born at the Naval Ocean Systems Center in San Diego, California, between 1979 and 1991 (Table 1). Because one birth was second generation (her mother had been born at NOSC) we were also able to quantify the amount of food energy in kcal required from weaning to adulthood.

Table 1. Weight, length, and age of Tursiops truncatus at time of conception.*

DOLPHIN:	AGE:	WEIGHT(kg):	LENGTH(cm):	ACTIVITY LEVEL:
TtOO1	19	157	247	High
Tt497	17	170	248	Moderate
Tt453	23	188	227	Low
Tt6l5	12	219	263	Moderate

*Indicates average of values collected over the 3 year period prior to conception.

feeding records were maintained for all animals on a daily basis (Fig. 1), and each new lot of fish used to feed the animals was analyzed for its nutrient content. An energy value for each fish species was calculated by figuring 9 kcal per gram of fat and 4 kcal per gram of protein: fat + protein = kcals. Taking 122 samples of these data from 1986 to 1991, an average value for each species was calculated (Table 2). These values were used to determine the daily energy consumption for each dolphin (kcal/day), and given in relation to dolphin weight, kcal/kg/d. [The kcal averages for these fish species may be useful for those facilities that do not have analyses for their fish. Many fish dealers have these results for each lot of fish. Ask the dealer if these results are available.] (Find Fig. 1 at end of paper)

Table 2. Fat, protein, and kcal values of food fish determined by proximate analysis.*

FISH TYPE	% FAT	% PROTEIN	KCAL/KG WET WT.	# SETS IN AVG
Pacific Mackerel	4.2	18.8	1130	37
Pacific Herring	8.71	16.5	1445	38
Columbia River Smelt	10.94	13.2	1512	29
Squid	.99	14.9	692	6
Capelin	3.75	14.4	912	3
Silver Smelt	2.74	16.4	903	9

*All analysis performed using the method for proximate analysis prescribed by the AOAC (Association of official Analytic Chemists).

To encourage a consistent diet, a daily ration was set for the cow once pregnancy was detected, and increased by small increments only when the dolphin demonstrated an unsatiated appetite. Usually the increase was in increments of 1 kg. Assuming a gestation period of 12 months, the date of conception was back calculated from the date of birth. Each of the calves was separated from its mom at 24 months of age.

Table 3. Percent increase of kcal intake during pregnancy and lactation compared to six month period prior to conception.

6 MONTH PERIOD	TtOOI	Tt497	Tt453	Tt615
1	0	23	12	-.03
2	6	46	37	7.3
3	129	147	204	
4	95	93	190	
5	78	143	220	
6	74	83		

Table 3 shows the percent increase in energy consumption during six 6-month periods from conception through weaning: 1, from conception to midpregnancy; 2, from midpregnancy to term; 3, first six month period of lactation; 4, second six month period of lactation; 5, third six month period of lactation; 6, fourth six month period of lactation. To compare the difference in kcal consumption from the non-pregnant state through gestation and lactation, kcal intake was calculated for each dolphin for a period of .6 months prior to conception, and then for each subsequent 6 month period. These values were compared and graphed in figure 2. A marked increase in kcal intake did not occur until the last stages of pregnancy. This supports other marine mammal studies that found that gestation does not impose a marked energy load until the last stages of pregnancy, while a large energy demand is seen during lactation. The greatest increase in energy consumption occurred in the first six month period of lactation; the animal that had the largest increase during that period was Tt453. Her intake increased 204%. TtOOI had the lowest percent increase at 129%. Tt497 consumed 147% more. It is interesting to note that the animal that exhibited the LOWEST increase in energy consumption (TtOOI) during the first six month period postpartum was a "working" animal with the HIGHEST activity level prior to conception and was very athletic and in very good physical condition. In contrast, the animal with the HIGHEST increase in kcal consumption (Tt453) was the animal with the LOWEST activity level prior to conceiving. This perhaps suggests that the energy demands of lactation may be offset if an animal is in excellent physical condition.

TURSIOPS TRUNCATUS
PREGNANCY AND LACTATION

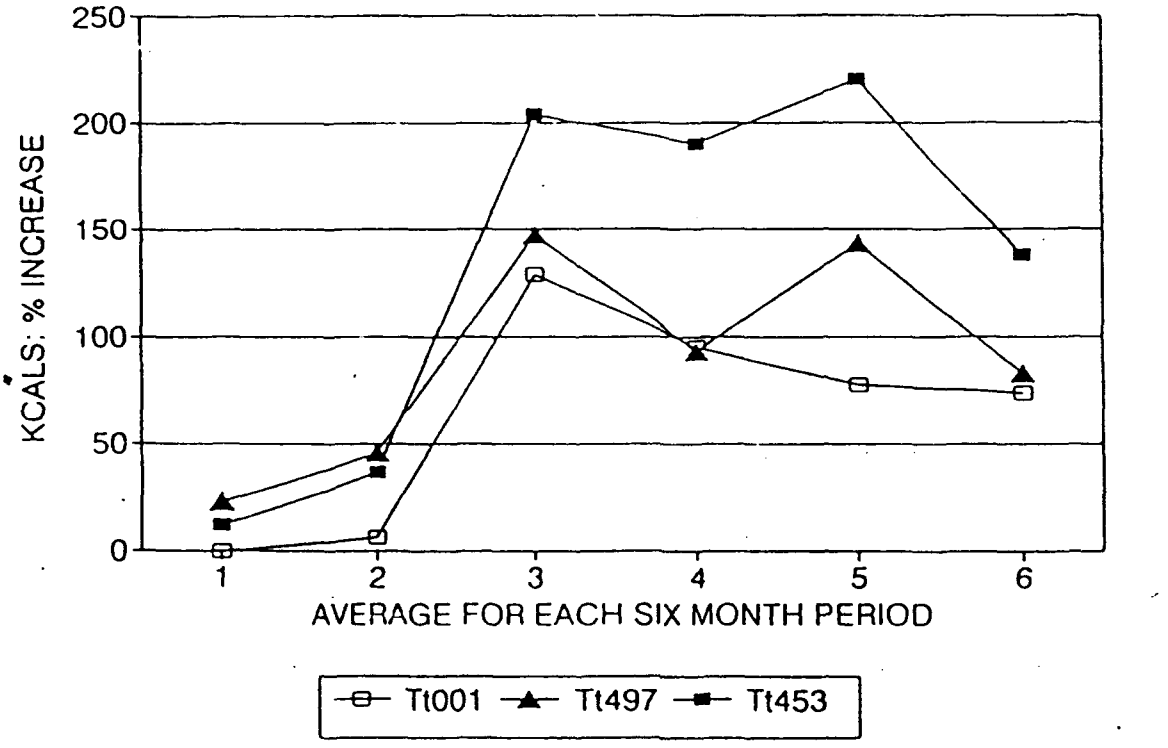


Figure 2. Percentage increase in energy consumption during six 6 month periods from conception through weaning: 1, from conception to midpregnancy; 2, from midpregnancy to term; 3, first six month period of lactation; 4, second six month period of lactation; 5, third six month period of lactation; 6, fourth six month period of lactation.

Another interesting note regarding TtOOI and the other two cows is that TtOOI's calf began to eat fish at 7 months of age, whereas the other two calves did not begin to eat fish until they were 15 months old. This may explain the increase in food intake during the 3rd six month period of lactation for Tt497 and Tt453 but not for TtOO1. As a calf begins to eat fish, its food demand on the cow decreases. It may be that the calf is somehow physiologically "encouraged" to begin weaning during the second six month period of lactation. This may be related to a change in the composition or amount of the milk which would result in a decreased energy demand on the cow. If the calf does not begin to wean during this period, the cow may then require another increase in energy intake to continue lactation. Because there has never been a serial study of bottlenose dolphin milk composition, these ideas will require further exploration.

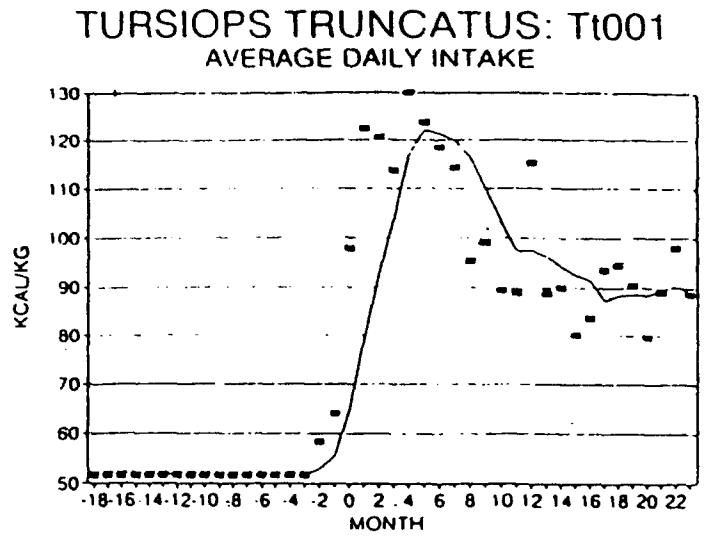
Table 4 and figure 3 show intake in terms of kcal/kg for each cow. The weight for the cows was taken to be an average of weights during the 3 years prior to conception.

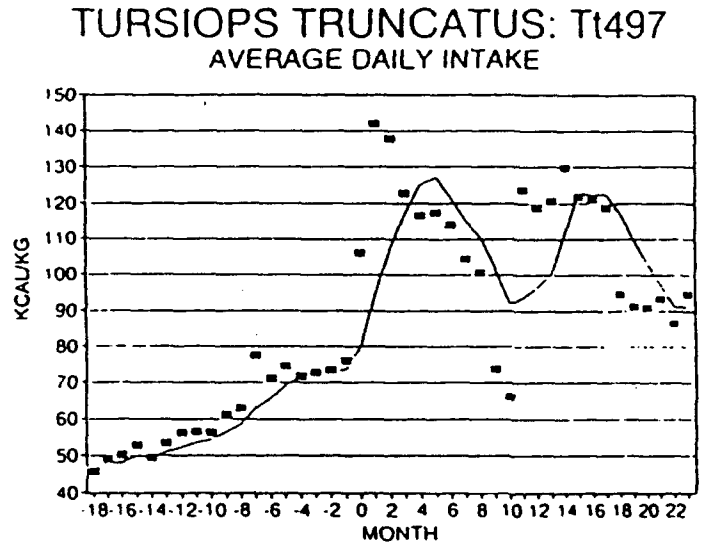
Intake (kcal/kg) was averaged for each animal for the 6 six month periods of the study. The range of the averages for the 3 cows in the first 6 months of lactation was 94-124 kcals/kg. (Because the newest calf is only 4 months old, results for her mom are not yet available.) This represents an average INCREASE of 67 kcal/kg/d for the first six months of lactation over their prepregnancy intake, and an increase of 51, 60, and 40 kcal/kg/d for the 3 subsequent six month periods. This suggests that a lactating bottlenose dolphin requires 90-130 kcal/kg during lactation; an increase of 60-80 kcal/kg over their nonpregnant diet. This amount will vary between animals and may be affected by animal size, water temperature, activity level, and fitness level.

Table 4. Energy intake: kcals per kg animal weight.
Increase in intake in ().
(*N/A: No data available; calf still nursing.)

6 MONTH PERIOD	TtOO1	Tt497	Tt453	Tt615
Prepregnancy	52	50	31	47
1	52(+O)	62(+12)	34(+3)	47 (+O)
2	55(+3)	73(+23)	42(+11)	50(+3)
3	118(+66)	124(+74)	94(+63)	N/A*
4	101(+49)	97(+47)	90(+59)	N/A*
5	92(+40)	122(+72)	99(+68)	N/A*
6	90(+38)	92(+42)	73(+42)	N/A*

The kcal intake of the calves (excluding kcals from nursing) was tracked and we were able to describe it in terms of kcal/kg/d once the calves were old enough to weigh them on a regular basis. only one of the calves has attained maturity at this writing, but preliminary data for all the calves suggests that in the early stages of growth, a calf may require 80-100 kcal/kg of fish (this is in addition to nursing), and after it is weaned and as it begins to mature, this requirement is reduced until it reaches ~~4565~~ 45-65 kcal/kg/d. The sample size of this study is admittedly small, but as more institutions begin to track energy consumption from birth through maturity the data will allow for higher confidence levels for such guidelines.





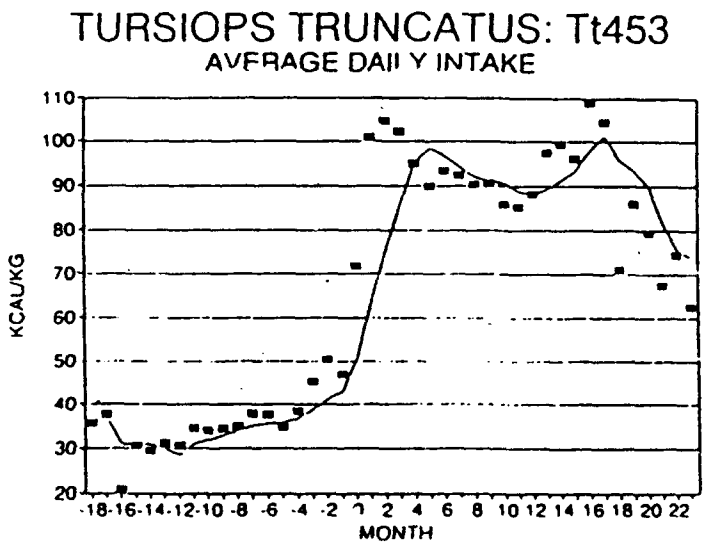


Figure 3. Average daily food intake (kcal/kg) by Tursiops truncatus TtOO1, Tt497, Tt453, from 18 months prior to parturition (-18), through birth (0), and continuing for 24 months of lactation (23).

Figure 1. Daily feeding record form.

FEEDING RECORDS

	PAC MAC (LOT NO.)	SPAN MAC (LOT NO.)	HERR (LOT NO.)	RIV SMLT (LOT NO.)	SILV SMLT (LOT NO.)	SOUD (LOT NO.)	OTHR (LOT NO.)	TOTAL	SEA	E	C	THI	HEP	MED	COMMENTS/ INITIALS
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2															
3															
4															
5															
6															
7															
8															
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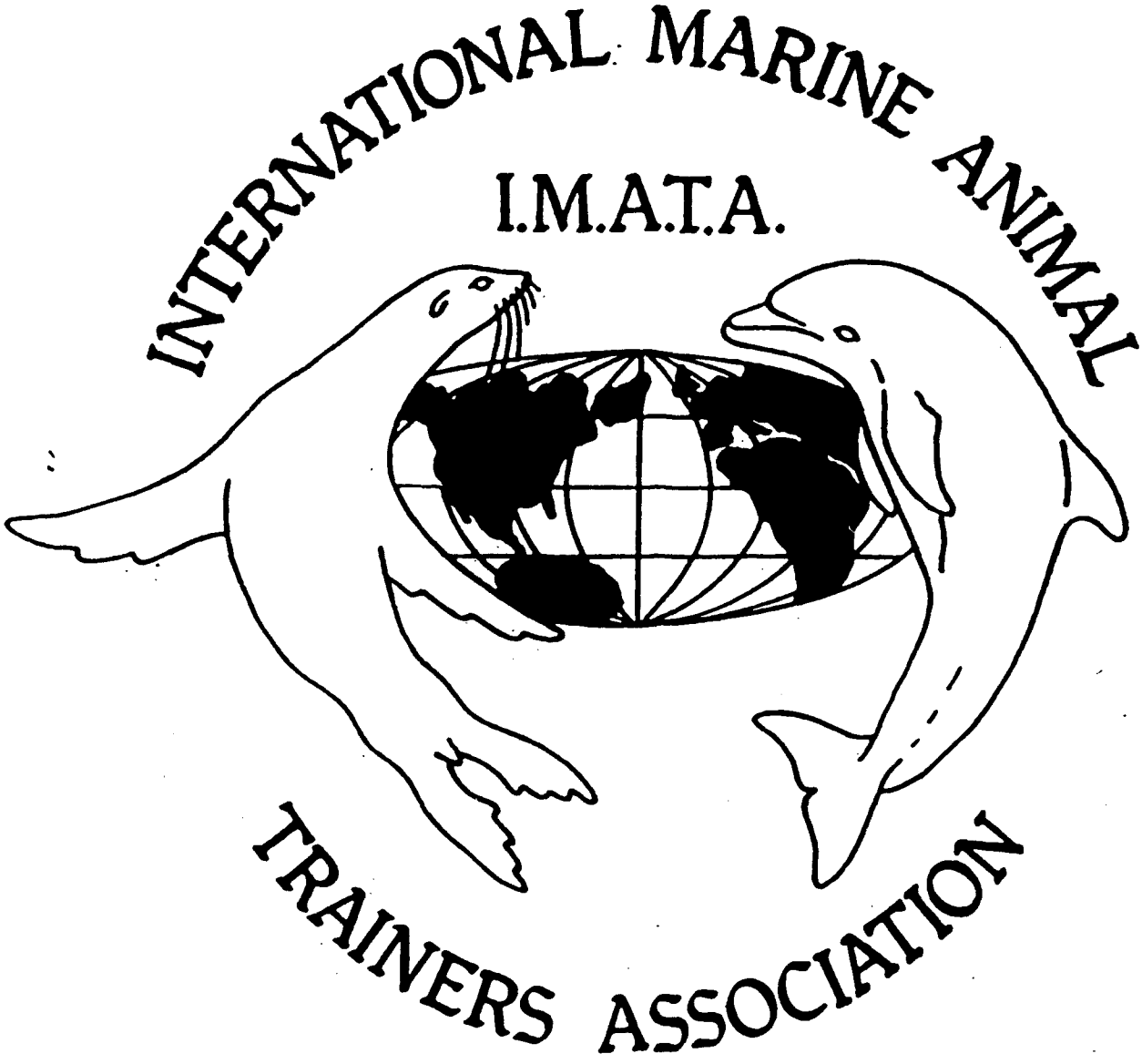
MONTH_____YEAR_____

ANIMAL NAME_____NUMBER_____



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